"Express Mail" mailing Label Number
EV 343784516 US

Date of Deposit June 20, 2003

PATENT APPLICATION
Case No. 1801/88

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
APPLICATION FOR UNITED STATES LETTERS PATENT

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CONNECTOR DEVICE

This application claims benefit of U.S. Provisional Application No. 60/397,439 filed July 19, 2002.

FIELD OF THE INVENTION

This invention is directed generally to breast pump assemblies and, more particularly, to an improved adapter for use within a breast pump assembly.

BACKGROUND OF THE INVENTION

Breast pump assemblies for extracting or expressing breast milk from a woman's breasts for later use to feed by an infant, have been available for years. Typically, these breast pump assemblies include a source of reduced pressure or vacuum, and at least one milking unit, which is includes a funnel-shaped hood, or breast shield, and a storage container. The breast shield is placed over the women's nipple and a substantial portion of the breast. A reduced pressure or vacuum is intermittently generated in the breast shield in a manner that causes milk to be expressed from the breast. The milk then typically flows to the storage container for later use. Although vacuum is what is typically employed in the operation of a breast pump assembly, positive pressure may also be conveyed in desired applications.

Generally, two types of breast pump assemblies have been marketed for use by nursing women: manually operated breast pump assemblies; and motor-driven breast pump assemblies. In manually operated breast pump assemblies, the intermittent vacuum is typically generated by means of a piston type pump. The piston pump generally includes a piston cylinder, which is connected to the breast shield, and a piston, slidably disposed within the piston cylinder. The piston has a hand-drivable piston rod connected thereto by which a person operating the breast pump assembly can manually move the piston back and forth within the piston cylinder, thus generating the vacuum. The intermittent vacuum in motor-driven breast pump assemblies is

typically generated by a similar piston pump, but the piston pump is connected to an electrically powered motor drive unit, and the motor drive unit moves the piston back and forth within the piston cylinder. There is a breast pump assembly sold by Medela, Inc. under the mark LACTINA®, which has a motor drive unit adapted for operating a piston pump which could otherwise be used for a manually operated breast pump assembly. An example of this manual, yet also motorized breast pump assembly is disclosed in U.S. Patent No. 5,007,899 ("the '899 patent"). The motor drive unit is separate from the breast shield. The vacuum generated when the motor drive unit moves the piston back and forth within the piston cylinder is transmitted to the breast shield through plastic tubing, which is connected to both the breast shield and the piston pump. The plastic tubing is often connected to the piston pump and/or the breast shield by use of an adapter. Because of the transfer of air throughout the breast pump assembly, the adapter must provide an airtight seal. Additionally, the user should be able to easily manipulate the adapter.

In the type of breast pump assembly disclosed in the '899 patent, where the breast shield can be used in a manual or a motorized mode, the breast shields and their pumps must be precisely matched in order to provide a safe and efficiently operating unit. The piston pumps used with the '899 patent breast pump assembly are, for example, precisely tuned to the operational function of the breast shield used therewith, as, for instance, concerning the volume of air moved in the cyclical action of the pump. Use of a different pump or breast shield can adversely affect the use of the subject breast pump assembly.

Accordingly, there is a demand for an adapter that provides a means for precisely matching breast shields and corresponding pumps. The present invention satisfies this demand.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide an improved adapter for use in a breast pump assembly that not only provides an airtight seal, but also serves as a means to prevent connection of unmatched and potentially deleterious components.

Another object of the present invention is to provide an improved female coupling component for use in the above-mentioned adapter.

A further object of the present invention is to provide an improved male coupling component for use in the above-mentioned adapter.

An additional object of the present invention is to provide a novel method of engaging male and female coupling components of an adapter, which provides an airtight seal and prevents connection of unmatched and potentially deleterious components.

One embodiment of the present invention provides an adapter for use in connecting a motor driven piston pump – that is, a fluid pressure or vacuum source - with a breast pump assembly. The adapter comprises in part a cap portion, which sealingly engages a piston cylinder of the piston pump. The cap portion defines, in part, a vacuum chamber therein which communicates with the interior of the piston cylinder and a lower well of the female coupling component, described in more detail hereinafter.

The adapter further comprises a male coupling component including a longitudinal axis having a first end and a second end. The male coupling component can be removably or fixedly attached at its first end to a tube for conveying the fluid pressure from the fluid pressure source. A passageway extends between the first end and the second end for further conveying the fluid pressure. A radially outwardly extending sealing portion is formed on an exterior surface of the male coupling component spaced from the second end.

The adapter further comprises a female coupling component sized and shaped for receiving the male coupling component. The female coupling component includes upper surfaces and lower surfaces, and a rim surface. The upper surface and the lower

surface are sized and shaped such that the female coupling component can receive the male coupling component therein.

The upper surface of the female coupling component defines an upper well having a first general diameter. The upper well is sized and shaped to match the size and shape of the radially outwardly extending sealing portion. When the male coupling component is received in the female coupling component, the sealing portion of the male coupling component is received in the upper well. Because the upper well matches the size and shape of the radially outwardly extending sealing portion, when the sealing portion of the male coupling component is received in the upper well, the upper surface engages a sealing surface of the sealing portion to form an airtight seal.

The lower surface of the female coupling component defines a lower well with a second general diameter, which is less than the first general diameter of the upper well. The lower well is sized and shaped to receive the second end of the male coupling component therein. The lower well is connected to the upper well by a rim surface. A channel is formed in the lower surface of the female coupling component. The channel includes an opening in the rim surface and is open at least at one point along the lower surface. The lower surface also includes a port therein which allows communication between the lower well and the vacuum chamber.

When the upper surface and the sealing surface of the sealing portion are sealingly engaged, ambient air is prevented from being drawn into the female coupling component, thereby permitting the pump to work at its optimal operating vacuum. When an unmatched male coupling component is used, ambient air is drawn into the upper well and is transmitted into the lower well through the channel, and then through the port, into the vacuum chamber, thus preventing the breast pump assembly from working at its optimal operating vacuum. Therefore, use of unmatched components can be potentially harmful.

These and other features and advantages of the present invention will be further understood upon consideration of the following detailed description of an embodiment of the present invention, taken in conjunction with the accompanying drawings, in which:

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view showing a preferred embodiment of a breast pump assembly of the kind incorporating the present invention;

FIG. 2 is a perspective view of an adapter, in accordance with the present invention;

FIG. 3A is an overhead view of the adapter of **FIG. 2**;

FIG. 3B is a perspective view of a second embodiment of an adapter;

FIG. 4 is another perspective view of the adapter of **FIG. 2**;

FIG. 5 a cross-sectional view of the adapter of **FIG. 2**;

FIG. 6A is an overhead perspective of one embodiment of a female coupling component, used in accordance with the present invention;

FIG. 6B is an overhead perspective of a second embodiment of a female coupling component, used in accordance with the present invention;

FIG. 7 is another overhead perspective of a female coupling component, used in accordance with the present invention, showing a connector entering the coupling component;

FIG. 8 is a perspective view of a pair of male coupling components, as used in the present invention;

FIG. 9 is a cross-sectional view of the male coupling components of **FIG. 8**;

FIG. 10 is a perspective view of another pair of male coupling component, as used in the present invention;

FIG. 11 is a cross-sectional view of the male coupling components of **FIG. 10**;

FIG. 12 is a perspective view of another male coupling component, as used in the present invention;

FIG. 13 is a cross-sectional view of the male coupling components of **FIG. 12**; and

FIG. 14A is a perspective view of a stopper as used in accordance with the

present invention;

FIG. 14B is a perspective view of a stopper as used in accordance with the present invention;

FIG. 14C is a perspective view of a stopper as used in accordance with the present invention; and

FIG. 14D is a perspective view of a stopper as used in accordance with the present invention.

DETAILED DESCRIPTION OF INVENTION

FIG. 1 illustrates, generally, the usage of one embodiment of the present invention within a breast pump assembly. One embodiment of a breast pump assembly **20** is shown in **FIG. 1**, and includes two milking units **22** and a motor drive unit **24**. Each milking unit **22** includes a breast shield **26** and a container **28**, such as a bottle, for collecting and storing the breast milk, which is connected to the lower portion of the breast shield **26**. The milking units **22** are adapted to be used with a piston pump **30**. A piston cylinder **32** of the piston pump **30** is connectable to the breast shield **26** to operate the milking unit **22** in a manually driven mode (i.e., the piston pump is reciprocated by hand). The piston cylinder **32** can be connected to the breast shield **26** directly, or by way of tubes **44** which can be attached to a tube attaching means (not shown) on the breast shield **26**. Details of this type of breast pump assembly and the piston pump can be gleaned from U.S. Pat. Nos. 4,929,229 and 4,857,051.

The motor drive unit **24** is also adapted to receive and hold and to mechanically operate the piston pump **30**. The motor drive unit **24** is substantially as shown and described in U.S. Pat. No. 5,007,899.

An improved cylinder holder, or adapter **34** of the present invention is attachable to the casing **36** of the motor drive unit **24**. The piston cylinder **32** is received in the adapter **34**. A piston **33**, having a piston rod **38** extending therefrom, is slidably disposed within the piston cylinder **32** and the piston rod **38** is releasably held at one end of an arm **40**. Arm **40** is mounted at its other end to the casing **36** of the motor

drive unit **24** for reciprocal movement of the piston rod **38**. As will be described in detail below, the adapter **34** includes female coupling components **42** (See **FIG. 3A and 3B**) for removably connecting tubes **44** to the breast shields **26** of the respective milking units **22**, via male coupling components **50** (See **FIG. 2**).

In brief, the motor drive unit **24** reciprocally moves the piston rod **38**, thus moving the piston **33** back and forth within the piston cylinder **32**. A rearward stroke of the piston rod **38** and thereby piston **33**, that is, such that the piston **33** is moved to a position where it is partially exposed from the cylinder **32**, generates a pressure change (usually a negative pressure) that is transmitted through the adapter **34** and the tubes **44** to one or both of the milking units **22**.

As seen in **FIGS. 2-5**, the adapter **34** of the present invention includes a cap portion **46** that is match-threaded at **48** for substantially airtight attachment to the piston cylinder **32**. **FIG. 5** shows that the inside of the cap portion **46** of one embodiment of the invention includes a seal ring **47** disposed therein for sealing engagement with the piston cylinder **32**. The cap portion **46**, defines in part, a vacuum chamber **52** that communicates with the interior of the piston cylinder **32** and, through ports **54** with the interior of the female coupling components **42**.

Further, the adapter **34** includes a post **56** that is removably received within a post hole (not shown) in the casing **36** to mount the adapter **34** to the motor drive unit **24**. **FIGS. 3A, 3B,** and **4** show that the exterior sidewall **46A** of the cap portion **46** includes a flange **51**. The flange **51** slides into an enlarged slot (also not shown) when the post **56** is inserted in the post hole and the adapter **34** rotated into place (in a similar manner as described in the '899 patent). Other means for mounting the adapter to the casing can be readily employed, of course.

As shown in **FIGS. 2, 3A**, and **3B**, adapter **34** generally includes female coupling components **42**. The female coupling components **42** are sized and shaped to snugly receive mating male coupling components **50** (discussed in further detail below and shown in **FIGS. 8-13**), which are removably or fixedly attached to the ends of the tubes **44**. This arrangement serves to provide an easily manipulated secure connection of the

tubes **44** to the ports **54** in the female coupling components **42**. For brevity, discussion will center on a single female coupling component **42**, but it is understood that the coupling components **42** contain identical elements.

Referring to **FIGS. 3A, 3B,** and **5-8**, the female coupling component **42** includes an upper surface **68**, a lower surface **70**, a bottom surface **72**, and a rim surface **74**. The upper surface **68** is sized and shaped to define an upper well **66** therein (**FIG. 5**). The lower surface **70** is sized and shaped to define a lower well **67** therein (**FIG. 5**). The lower surface **70** has a port **54** therein, through which air, or any fluid, can pass from the lower well **67** to the vacuum chamber **52**, or vice versa. A channel **76** is formed in the lower surface **70** and is in communication with the port **54**.

The upper well **66** has a diameter **D1**. The lower well **67** has a diameter **D2**. Diameter **D1** is greater than diameter **D2**. The upper well **66** is connected to the lower well **67** by the rim surface **74**. The channel **76** extends from an opening **78** in the rim surface **74** to the bottom surface **72** and is open to the lower well **67** at one or more points along the lower surface **70**.

FIGS. 6A and **6B** illustrate overhead detailed schematics of two embodiments of a female coupling component **42**. The bottom surface **72** of the lower well **67** has at least one radially extending groove **80** formed therein. The groove **80** is in fluid communication with the channel **76** formed in the lower surface **70** and is open to the lower well **67** at one or more points along the bottom surface **72**.

The upper well **66** is sized and shaped to receive and thereby provide a snug fit with the male coupling component **50**. As depicted in one embodiment, the upper well **66** comprises a generally polygonal or slightly rounded triangular shape. It is understood however, that the upper well **66** can be of any shape provided it is sized to match a sealing portion **88** of a male coupling component **50** as will be described in further detail hereinafter.

Referring again to **FIGS. 3A** and **3B**, adapter **34** also includes a stopper mount **58A, 58B** and a stopper rest **60**. Additionally, the stopper mount **58A** further includes an aperture surface **62A, 62B** that defines an aperture **64**. As shown in **FIG. 3A**, the

aperture surface **62A** may extend outward from the adapter **34** such that stopper mount **58A** is sized and shaped as an elevated cylinder. Alternatively, as shown in **FIG. 3B**, aperture surface **62B** may extend inward into the adapter **34** such that stopper mount **58B** is a well within the adapter **34**. In accordance with one embodiment of the present invention, stopper mount **58A, 58B** receives a mounting end **98A, 98B** of stopper **96A, 96B** (see **FIGS. 14A, 14B, 14C** and **14D**) thereon, to mount the stopper **96A, 96B** on the adapter **34**.

The stopper **96A, 96B** is shown generally in **FIGS. 14A, 14B, 14C** and **14D**. Plug **100A, 100B** of stopper **96A, 96B** may be placed, when not in use as a stopper, in the stopper rest **60**. Preferably, stopper **96A, 96B** is used to "cut off" one of multiple female coupling components **42** in the event that the user wishes to only utilize one of the milking units **22**. Additionally, stopper **96A, 96B** may include gripping ridges **102** on a top surface **101** as depicted in **FIG. 14C**.

As shown in **FIG. 2**, stopper rest **60** is similar in shape and size, to the upper well **66**. The purpose for this is that the plug **100A, 100B** of the stopper **96A, 96B** is shaped similarly to a sealing portion **88** (see **FIG. 8**) to snugly fit into the stopper rest **60** (when not is use), and the upper well **66** of the female coupling component **42** (when in use).

As discussed earlier, tubes **44** are attached to male coupling components **50**, which in turn may be inserted into corresponding female coupling components **42**. This arrangement serves to provide an easily manipulatable and secure connection of tubes **44**, via male coupling components **50**, to adapter **34**.

FIGS. 8-9 illustrate various perspectives of one embodiment of a male coupling component **50**. As shown in detail in **FIG. 8**, male coupling component **50** is shown with a first end **82** to which a tube **44** is attached, and a second end **84**. A passageway **86** extends through the male coupling component **50** between the first end **82** and the second end **84** for conveying the fluid pressure. Additionally, the connector **50** includes a radially outwardly extending sealing portion **88** formed on the male coupling component **50** between the first end **82** and the second end **84** and spaced from the second end **84**. As shown in **FIG. 8**, the sealing portion **88** can be of a generally

polygonal or slightly rounded triangular shape. It is understood, however, that the sealing portion **88** can be of any shape, so long as it matches the shape of the upper well **66** of the female coupling component **42**. The sealing portion **88** also has a sealing surface **90** that includes at least one circumferential sealing ring **92** thereon, which engages the upper surface **68** of the upper well **66** to form a substantially airtight seal such that ambient air is prevented from entering the female coupling component **42**. The upper surface **68** may include at least one circumferential groove (not shown) therein that engages with the circumferential sealing ring **92** to form the substantially airtight seal.

FIGS. 10-11 illustrate various perspectives of another embodiment of a male coupling component **150**. As shown in detail in **FIG. 10,** male coupling component **150** is shown with a first end **182** to which a vacuum tube **44** is attached, and a second end **184**. A gripping portion **194** surrounds the first end **182**. **FIGS. 10 & 11** show that the gripping portion **194** has a slightly concaved exterior surface **196** and a cylindrical interior surface **198** with a diameter **D3** greater than diameter **D4** of the first end **182** such that a tube **44** can be attached to the first end **182**, yet snugly received within the interior surface **198** of the gripping portion **194**. A passageway **186** extends through the male coupling component **150** between the first end **182** and the second end **184** for conveying the fluid pressure. Additionally, the male coupling component **150** includes a radially outwardly extending sealing portion **188** formed on the male coupling component **150** between the first end **182** and the second end **184**, spaced from the second end **184**. The sealing portion **188** can be of any shape so long as it is sized and shaped to match the size and shape of the upper well **66** of the female coupling component **42**, but is depicted as having a generally polygonal or slightly rounded triangular shape. The sealing portion **188** has a sealing surface **190** that includes at least one circumferential sealing ring **192** thereon, which engages the upper surface **68** of the upper well **66** to form a substantially airtight seal such that ambient air is prevented from entering the female coupling component **42**. The upper surface **68** may

include at least one circumferential groove (not shown) therein that engages with the circumferential sealing ring **192** to form the substantially airtight seal.

FIGS. 12-13 illustrate various perspectives of yet another embodiment of a male coupling component **250**. As shown in detail in **FIG. 12**, male coupling component **250** is shown with a first end **282** to which a tube **44** is attached, and a second end **284**. A passageway **286** extends through the male coupling component **250** between the first end **282** and the second end **284** for conveying the fluid pressure. Additionally, the connector **250** includes a radially outwardly extending sealing portion **288** formed on the male coupling component **250** between the first end **282** and the second end **284**, spaced from the second end **284**. The sealing portion **288** can be of any shape, so long as it is sized and shaped to match the size and shape of the upper well **66** of the female coupling component **42**, but is depicted as having a generally circular shape. The sealing portion **288** has a sealing surface **290** that engages the upper surface **68** of the upper well **66** to form a substantially airtight seal such that ambient air is prevented from entering the coupling component **42**.

As a result of the unique design of the male coupling components **50** and the female coupling components **42**, described above, the present invention provides for a unique fit between the male coupling components **50** and the female coupling components **42**. This unique design assures that only this coupling component and connector will be successfully mated, thereby assuring that only properly matched equipment will be used.

It should be appreciated that the embodiments described above are to be considered in all respects only illustrative and not restrictive. The scope of the invention is indicated by the following claims rather than by the foregoing description. All changes that come within the meaning and range of equivalents are to be embraced within their scope.